MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1 , 2017/2018

ERT3026 – AUTOMATION
(RE)

27 OCTOBER 2017
9.00 am. – 11.00 am.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This Question paper consists of **6 pages** including cover page and Appendix with 4 **Questions** only.
2. Attempt **ALL** questions. The distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

Question 1

(a) A simple load cell consists of an aluminum post of 2.50 cm radius with a detector and compensation strain gages. The 120 Ω strain gauges are used in the bridge of **Figure Q1a** with V = 2V, R_1=R_2=R_D =120Ω ,*Gage Factor = 2.13* and E for aluminum = 6.89×10^{10} N/m^2.
Determine the change of resistance and Variation of bridge offset for load of 0 to 22240N. **[13 marks]**

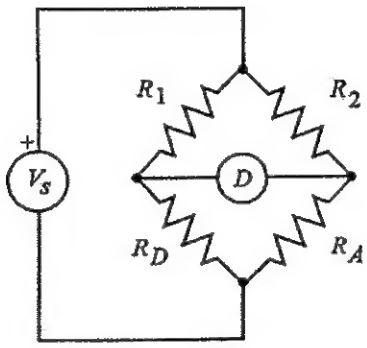

Figure Q1a

(b) A DC servomotor has a torque constant = 0.088 N-m/A and a voltage constant = 0.12 V/(rad/sec). The armature resistance is 2.3 Ω. A terminal voltage of 30 V is used to operate the motor.

Determine:

(i) The starting torque generated by the motor just as the voltage is applied. **[3 marks]**

(ii) The maximum speed at a torque of zero. **[3 marks]**

(iii) The operating point of the motor when it is connected to a load whose torque characteristic is proportional to speed with a constant of proportionality = 0.011 N-m/(rad/sec). **[6 marks]**

Continued...

Question 2

(a) Construct the ladder logic diagrams for the NAND gate and the NOR gate.

[6 marks]

(b) If the timer of PLC can be achieved only 999 seconds, in order to extend the delay to 1500 seconds, design cascading timers to achieve such requirement.

[6 marks]

(c) XYZ company wants to implement a packing line control system for apples by using 32-bit OMRON PLC to satisfy the following operation sequence.

- When the start push button is pressed, the box conveyor is moving.
- Upon detection of box presents, the box conveyor stops
- And then apple conveyor starts.
- When the box is full with 20 apples, the apples conveyor stops.
- And then the box conveyor starts again.
- Counter will be reset and operation repeats until stop push button is pressed.

Write a PLC ladder diagram by using the Input/Output assignment as show in **Table Q2-(c).**

[13 marks]

Table Q2-(c) The Input/Output Assignment for Question 2(c)

Input/Output	Devices
0000	Start Push Button(PB1)
0001	Stop Push Button(PB2)
0002	Part present Sensor (SE1)
0003	Box present Sensor (SE2)
1001	Apple Conveyor
1002	Box Conveyor

Continued...

Question 3

(a) Four forklift trucks are used to deliver pallet loads of parts between work cells in a factory. Average travel distance loaded is 350 ft and the travel distance empty is estimated to be the same.

The trucks are driven at an average speed of 3 miles/hr when loaded and 4 miles/hr when empty. Terminal time per delivery averages 1.0 min (load = 0.5 min and unload = 0.5 min).

If the traffic factor is assumed to be 0.90, availability is 100%, and worker efficiency is 0.95, what is the maximum hourly delivery rate of the four trucks?

[12 marks]

(b) A 23-station transfer line has been logged for 2400 min. During this period there were a total of 158 downtime occurrences on the line.

The type of downtime occurrence, the number of occurrences, and total time lost for each type is shown in **Table Q3 (b).**

The transfer line performs a sequence of machining operations, the longest of which takes 0.42 min. The transfer mechanism takes 0.08 min to index the parts from one station to the next each cycle.

Assuming no parts removal when the line jams.

Based on this observation period, determine how many parts were produced and downtime proportion?

[13 marks]

Table Q3 (b)

Type of downtime	Number of occurrences	Total time lost
Associated with stations:		
Tool-related causes	104	520 min
Mechanical failures	21	189 min
Miscellaneous	7	84 min
Transfer mechanism	26	78 min

Continued...

Question 4

At manufacturing factory, the system engineer chose a flexible manufacturing cell layout after considering a number of designs. A layout consists of two machining workstations plus a load/unload station. The detail of FMC layout is shown in **Table Q 4.1.**

Table Q 4.1: The Detail of FMC Layout

Station 1	Load and unload	2 human worker
Station 2	Milling operations	5 CNC milling machines
Station 3	Drilling operations	5 CNC drilling machines

The three stations are connected by a part handling system that has two work carriers and the mean transport time in the system is 2.0 min. The FMC produces three products, A, B, and C. The part mix fractions and process routings for the three parts are shown in the **Table Q4.2**. The operation frequency $f_{ijk} = 1.0$ for all operations.

Determine:

(a) Maximum production rate of the FMC, **[11 marks]**

(b) Corresponding production rates of each product, **[4 marks]**

(c) Utilization of each station in the system. **[5marks]**

(d) Number of busy server at each station in the system. **[5marks]**

Table Q 4.2: The Part Mix Fractions and Process Routings

Product j	Product mix p_j	Operation k	Station i	Processing Time t_{ijk}
A	0.25	1	1	3 min
		2	2	15 min
		3	3	30 min
		4	1	2 min
B	0.35	1	1	3 min
		2	2	20 min
		3	3	12 min
		4	1	2 min
C	0.40	1	1	3 min
		2	2	18 min
		3	3	25 min
		4	1	2 min

End of Page

APPENDIX

$T_p = T_c + FT_d$	$R_p = \frac{1}{T_p}$	$T_p = T_c + \sum_j F_j T_{dj}$
$WL = R_f T_C$	$T_C = T_L + \frac{L_d}{v_C} + T_U + \frac{L_e}{v_e}$ $T_d = \frac{L_d}{v_C}$	$AT = 60 AT_f E$ $R_f = R_L = \frac{v_c}{S_c} \leq \frac{1}{T_L}$
$n_C = \frac{WL}{AT}$ $R_{dv} = \frac{AT}{T_C}$ $F = \sum_i^n p_i$	$f_p = 1/T_c$ $T_c = s_p/v_c$ $T_C = Max\{T_{si}\} + T_r$	$D = \frac{FT_d}{T_p}$ $E = \frac{T_c}{T_p}$
$d = \frac{nT_s - T_{wc}}{nT_s}$	$WL_i = \sum_j \sum_k \iota_{ijk} f_{ijk} p_j$	$n_t = \left(\sum_i \sum_j \sum_k f_{ijk} p_j \right) - 1$
$WL_{n+1} = n_t t_{n+1}$	$R_p^* = \frac{s^*}{WL^*}$	$R_{pj}^* = p_j(R_p^*) = p_j \frac{s^*}{WL^*}$
$U_i = \frac{WL_i}{s_i}(R_p^*)$	$\overline{U} = \frac{\sum_{i+1}^{n+1} U_i}{n+1}$	$\overline{U_s} = \frac{\sum_{i+1}^{n+1} s_i U_i}{\sum_{i=1}^{n} s_i}$
$\sigma = \frac{F}{A}$ $\varepsilon = \frac{\sigma}{E}$	$F_i = PA_i$ $V = \frac{Q}{A}$	$G = \frac{\Delta R/R}{\varepsilon}$ $\Delta V_0 = V_1 \left(\frac{\Delta R_1}{R_1 + R_2} \right)$